Patient-controlled lidocaine analgesia for acromioplasty surgery

William J. Mallon, MD, and Cathy W. Thomas, MD, *Durham, NC*

Twenty-four consecutive patients undergoing shoulder acromioplasty were given postoperative analgesia with a new method in which a patient-controlled continuous infusion of lidocaine infiltrated the subacromial space. Seventeen of the acromioplasties were done with arthroscopy, whereas 7 were performed with an open procedure. A 2% solution of lidocaine without epinephrine was used for both a continuous dose of 2 cc/h and patient-controlled interval doses of 1 cc administered at 15-minute intervals. The catheter was left in place for 72 hours. We prospectively studied complications, the patient's subjective pain level, the amount of supplementary pain medication used, and serum levels of lidocaine. In addition, we evaluated a control group of 24 patients undergoing acromioplasty by the same surgeon without the use of this method of pain control. No wound complications occurred. No adverse reactions to lidocaine or overdose of lidocaine occurred. Blood levels of lidocaine averaged 0.3 μg/mL in the 12 patients studied. Subjective pain levels and the amount of supplementary pain medication used were both lower in the group receiving patient-controlled lidocaine analgesia at statistically significant levels (P = .168 measuring subjective pain level, and P = .0212 measuring supplementary pain medication use). Patient-controlled lidocaine analgesia in the subacromial space appears to be a safe method for achieving high levels of pain control in patients undergoing an acromioplasty. (J Shoulder Elbow Surg 2000;9:85-8.)

Acromioplasty is one of the most frequently performed shoulder operations. Historically, it was done with an open procedure, but since the late 1980s it has been frequently performed with an arthroscopic approach.[6,7,9,10,15,16] In Neer's[14] original description of the open technique, he described patients staying in the hospital for 5 to 10 days. In the current era of medical cost containment, acromioplasty is usually performed as an outpatient procedure.

Not all patients tolerate the pain of acromioplasty surgery well, done either open or with arthroscopy, as outpatients. To overcome this problem and allow for immediate postoperative range-of-motion exercises, we have developed a new method of giving postoperative pain relief with an indwelling catheter and with patient-controlled lidocaine analgesia (PCLA) in the subacromial space.

From Triangle Orthopaedic Associates, the Division of Orthopaedic Surgery, Duke University Medical Center, Durham, NC, and Durham Anesthesia Associates, Durham Regional Hospital.

Reprint requests: William J. Mallon, MD, Triangle Orthopaedic Associates, Inc, 2609 North Duke St, Suite 900, Durham, NC 27704.

1058-2746/2000/$12.00 + 0 **32/1/104092**
doi:10.1067/mse.2000.104092

MATERIAL AND METHODS

Twenty-four consecutive patients undergoing acromioplasty were given postoperative analgesia with a patient-controlled continuous infusion of lidocaine infiltrating the subacromial space. Seventeen of the acromioplasties were done with arthroscopy, whereas 7 were done with an open procedure. At the end of the procedure a small (1 mm) catheter normally used for indwelling epidural anesthesia was placed within the confines of the subacromial space under direct vision (Figure 1). The catheter was connected to a pump that allowed both continuous infusion of medication and patient-controlled interval boluses and had safety controls that helped prevent a possible overdose of lidocaine. For short-term immediate postoperative pain control, at the end of the procedure the subacromial space was also infiltrated with 15 to 20 mL 0.25% bupivacaine through the catheter.

A 2% solution of lidocaine without epinephrine was used for the patient-controlled analgesia. A continuous dose of 2 cc/h was administered with interval doses of 1 cc self-administered at 15-minute intervals as needed. The catheter was left in place for 72 hours. Initially all patients were kept overnight in an overnight-stay surgical center for monitoring. All patients were begun on active-assisted and active motion exercises on the first postoperative day.

We prospectively studied complications, the patients' subjective pain levels, the amount of supplementary pain medication required, and serum levels of lidocaine (obtained 24 hours after the infusion was begun). In addition, we compared this group with a control group of 24 consecutive patients who underwent acromioplasty without the addition of patient-controlled lidocaine analgesia. These patients did receive a dose of bupivacaine into the subacromial space at the end of the procedure, as did the PCLA group.

We also compared the costs of this method of pain control with standard costs for outpatient surgery with general anesthesia, outpatient surgery with supplemental interscalene block anesthesia, and inpatient surgery with a 1-night stay with patient-controlled morphine analgesia for pain control.

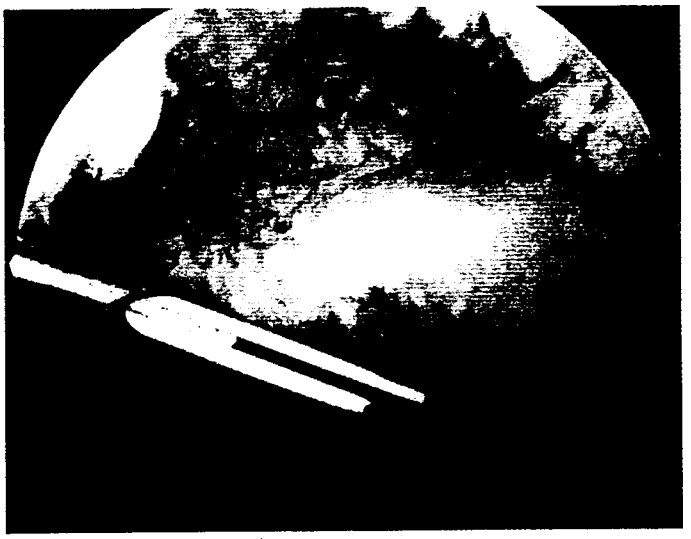

Figure 1 Arthroscopic image of catheter being placed in subacromial space under direct vision after arthroscopic acromioplasty.

RESULTS

The only complication was the dislodgement of 2 catheters before 72 hours. This occurred in both cases during dressing changes, but the problem has not recurred since a new method of securing the catheter to the dressing has been used. These patients were included in the results for the PCLA group.

No wound complications occurred. No adverse reactions to lidocaine or overdose of lidocaine occurred. Blood levels of lidocaine averaged 0.3 μg/mL (range 0.0 to 0.8 μg/mL) in the 12 patients studied, which is far below the level of 2 μg/mL that is normally considered a maximal safe serum level of lidocaine.

The patients' pain was subjectively classified by them as none (0), mild (1), moderate (2), and severe (3). During the 3 days of lidocaine infusion, 3 patients stated that they had no pain, 11 termed their pain mild, 7 considered their pain moderate, and 3 termed their pain level severe. In the control group, of 24 patients who did not have PCLA, 1 had no pain, 5 termed their pain mild, 9 termed it moderate, and 9 classified their pain as severe during the first 3 postoperative days. Mean pain levels were 1.4 for patients using PCLA and 2.1 for patients not using PCLA, a statistically significant difference ($P = .0168$, Wilcoxon rank-sum test).

All patients were given a prescription for oral Percocet (acetaminophen with 5 mg oxycodone) as supplemental pain medication. The patients using PCLA used a mean of 6.8 tablets in the first 72 hours after surgery, whereas the patients not using PCLA used a mean of 11.2 tablets in the first 72 hours after surgery, also a statistically significant difference ($P = .0212$, Student 2-tailed t test).

The base cost for 3 days of PCLA was $255, with additional costs of $65 for each nursing visit. On average, one home nursing visit per patient was required, giving an average cost of $320 for this method of postoperative pain control for 3 days.

At our hospital current anesthetic charges are the same for general anesthesia and interscalene block anesthesia, if used as the primary method. A supplemental interscalene block added at the end of a general anesthetic for postoperative pain management generates an additional charge of $300. One night of postoperative stay in our hospital with a patient-controlled anesthesia machine with morphine sulfate had an average cost of $584 after acromioplasty surgery in this series.

DISCUSSION

The ideal approach for anesthesia after acromioplasty surgery would be to provide complete pain relief for multiple days after the surgery at no risk and no additional cost to the patient. In the past general anesthesia has been the method of choice for shoulder surgery. This provides no additional postoperative pain relief other than that which may be administered by the surgeon as a local block at the end of the procedure, which, although effective, has a limited duration.

Many shoulder surgeons currently use interscalene block anesthesia for shoulder surgery. This has the advantage of providing from 8 to 24 hours of postoperative pain relief.[18] In certain situations interscalene anesthetic blocks can be operator-dependent. In such cases an additional charge to the patient may be generated by the addition of general anesthesia to the interscalene block.

PCLA used after acromioplasty surgery provides up to 3 days of excellent pain relief to the patient. This method has been proven safe in our hands with no significant complications. Anesthesia studies have shown that control of the patient's pain in the immediate postoperative period is critically important. Patients who have minimal pain in the immediate postoperative period often report lower levels of long-term pain.[11,19] PCLA is an excellent method of achieving this goal. The patient is essentially giving himself or herself a local anesthetic block for 3 days after acromioplasty surgery. Subjectively, we believe that patients who have had this method of pain control have done better over the long term than they did before our institution of this method.

Risk of the procedure was a major concern when we initially began using this technique and study. Patients were initially kept overnight for monitoring and for measurement of lidocaine levels, but we no longer do this and do not believe it is necessary. We have had no complications related to the lidocaine, and lidocaine levels have been uniformly low. Since this study was completed, we now use it routinely and have experience with more than 500 cases with no complications related to the method.

Colleagues initially expressed concern over the injection of lidocaine in apposition to the exposed bleeding cancellous bony surface created by the acromioplasty. However, the area of the exposed bone is probably no more than 3 cm^2. In addition, our doses of lidocaine were designed to provide a margin of safety, even with an intravenous injection.

Maximum dosages received by the patient are 6 cc/h or 120 mg of lidocaine per hour. Maximum recommended doses of lidocaine for local anesthetic blockade are 4 mg/kg when used without epinephrine.[8] Even in a smaller adult weighing 60 kg, therefore, a 240 mg total dose of lidocaine per hour would be a safe dose. In even smaller adults the continuous and interval doses can be adjusted downward.

Lidocaine has a metabolic half-life of approximately 1 hour.[8] In experiments with rats, lidocaine levels, when injected intramuscularly without epinephrine, decreased to zero within 2 hours of injection.[5] Sung and Truant[17] also noted that lidocaine is not detectable in the blood 2 hours after an intravenous injection. Because lidocaine is metabolized rapidly,[5,8,17] probably no more than 60 mg lidocaine is available to the body's tissues at any time, giving this method a wide therapeutic margin.

During intravenous use of lidocaine for antiarrhythmic effects, approximately 0.7 to 1.4 mg/kg is used initially.[1,8] Infusion rates of 1 to 4 mg/min produce therapeutic concentrations in the plasma of 1 to 5 μg/mL.[1,8] Our doses with PCLA allow a maximal injection of 120 mg/h, or effectively, a maximal infusion rate of 2 mg/min.

At plasma concentrations of 5 μg/mL, symptomatic side effects are described as subtle, including perioral paresthesia, mild drowsiness, and agitation.[5,8] Higher concentrations can affect hearing and can cause disorientation, convulsions, seizures, and respiratory arrest.[5,8] In one study[3] testing continuous infusion of lidocaine, plasma levels of 6.5 μg/mL did not produce any side effects. Bromage and Robson[4] noted that lidocaine levels of 5.0 μg/mL were not unduly high and that serious central nervous system reactions did not occur until lidocaine levels reached 10 μg/mL. However, de Jong[5] noted mild central nervous system symptoms at levels of 1.5 μg/mL and serious central nervous system toxicity at levels of 5.3 μg/mL. The plasma levels achieved by PCLA have been far below these levels at which side effects occurred in all studies.

Lidocaine is cleared by the liver.[2,5,8,12] In patients with elevated liver enzyme levels or known liver disease, the use of PCLA may cause elevated plasma levels of lidocaine. In patients with known liver disease or a history of elevated liver enzymes, a lower dose of PCLA may be advisable, or the method should not be used at all. Patients with a history of a seizure disorder should probably not receive PCLA because of the risk of lowering the seizure threshold with any significant plasma level of lidocaine.

There have been no wound problems from leaving the catheter in place for 3 days, and surgical drains are often left in place for 3 days. In this case the drain (catheter) is quite small and is covered by the sterile surgical dressing throughout the period that PCLA is used. Lidocaine is known to have minimal local toxic side effects,[13] and as is well-known, lidocaine, although at lower doses, is frequently used for injection into the subacromial space as part of the impingement test, with no reported toxicity to the local tissues.

SUMMARY

PCLA has proven to be an excellent method of providing pain relief to patients in the first 3 days after acromioplasty surgery. This method has allowed patients to begin early range-of-motion exercises and expedite their recovery from this surgery with minimal pain. The method has also been proven to be safe both in terms of lack of clinical complications and in relation to serum lidocaine levels, which were far below toxic levels in all patients studied. PCLA is also comparable to other anesthetic methods in terms of costs to patients.

REFERENCES

1. American Heart Association. Textbook of advanced cardiac life support. 2nd ed. New York: American Heart Association; 1987.
2. Astra Pharmaceutical Products. Xylocaine: chemistry, pharmacology, and clinical applications. Worcester, MA: Astra; 1960.
3. Bassan MM, Weinstein SR, Mandel WJ. Use of lidocaine by continuous infusion. Am Heart J 1974;87:302-3.

4. Bromage PR, Robson JG. Concentrations of lignocaine in the blood after intravenous, intramuscular, epidural, and endotracheal administration. Anaesthesia 1961;16:461-5.
5. De Jong RH. Physiology and pharmacology of local anaesthesia. Springfield, IL: CC Thomas; 1970.
6. Ellman H. Arthroscopic subacromial decompression: analysis of one- to three-year results. Arthroscopy 1987;3:173-81.
7. Esch JC, Ozerkis LR, Helgager JA, Kane N, Lilliott N. Arthroscopic subacromial decompression: results according to degree of rotator cuff tear. Arthroscopy 1988;4:241-9.
8. Goodman LS, Gilman A, eds. The pharmacological basis of therapeutics. 5th ed. New York: Macmillan; 1975. p. 312, 320, 857-61.
9. Hawkins RJ, Bokor DJ. Clinical evaluation of shoulder problems. In: Rockwood CA, Matsen FA, editors. The shoulder. Philadelphia: WB Saunders; 1990. p. 149-77.
10. Johnson LL. Diagnostic and surgical arthroscopy of the shoulder. St Louis: Mosby 1993.
11. Katz J, Kavanagh BP. Preemptive analgesia: clinical evidence of neuroplasticity contributing to postoperative pain. Anesthesiology 1992;77:439-46.
12. LeLorier J, Moisan R, Gagne J, Caillé G. Effect of the duration of infusion on the disposition of lidocaine in dogs. J Pharmacol Exp Ther 1977;203:507-11.
13. Löfgren N. Studies on local anesthetics. Xylocaine: a new synthetic drug. Stockholm: Höggstroms; 1948.
14. Neer CS. Anterior acromioplasty for chronic impingement syndrome in the shoulder. A preliminary report. J Bone Joint Surg Am 1972;54A:41-50.
15. Paulos LE, Harner CD, Parker RD. Arthroscopic subacromial decompression for impingement syndrome of the shoulder. Tech Orthop 1988;3:33-8.
16. Snyder SJ. Shoulder arthroscopy. New York: McGraw-Hill; 1994. p. 133-78.
17. Sung CY, Truant AP. The physiological disposition of lidocaine and its comparison in some respects with procaine. J Pharmacol Exp Ther 1954;112:432-43.
18. Vlessides M. Pre-op interscalene plexus block said to reduce pain after shoulder surgery. Anesth News, November 1994.
19. Woolf CJ, Chong MS. Preemptive analgesia: treating postoperative pain by preventing the establishment of central sensitization. Anesth Analg 1993;77:362-79.